

Title: Method and device for treating a liquid effluent heavily loaded especially with nitrogen and phosphorus

The present invention relates to a method for treating a liquid effluent heavily loaded especially with nitrogen and phosphorus, and also a device for implementing this method.

Liquid effluents heavily loaded especially with nitrogen and phosphorus, whether of urban, agricultural or industrial origin, pose a serious problem especially in the field of the environment. All the developing controversy concerning the level of nitrate present in ground water must be borne in mind.

National and/or international legislations tend increasingly to prohibit any disposal of liquid effluents, the amount of nitrogenized material of which is greater than a threshold which is tending to fall as a result of action by various pressure groups. Likewise as regards phosphorus, the legislation limits the quantities tolerated for materials which are to be spread as manure.

Furthermore, a benefit from the above-mentioned liquid effluents is often obtained by spreading them as manure, the nauseating odour which results being a source of conflict with the surrounding neighbourhood.

Amongst the liquid effluents heavily loaded especially with nitrogen and/or with phosphorus, primarily pig slurry should be mentioned, and also liquid sludge created by purification stations.

Indeed, a certain number of methods and/or devices have already been proposed for reducing the nuisance caused by the spreading of such liquid effluents, but none of these is entirely satisfactory, especially with respect to the regulations which are currently envisaged.

Thus, one of the aims of the present invention is to provide a method for treating a liquid effluent heavily loaded especially with nitrogen and with phosphorus, which allows the nitrogenized charge to be reduced at least to the legally acceptable threshold.

Another aim of the present invention is to provide a method of this nature which allows such liquid effluents to be deodorized.

~~An additional aim of the present invention is to provide such a method which is simple to implement at low cost.~~

These aims, and also others which will later become apparent, are achieved by a method for treating a liquid effluent heavily loaded especially with nitrogen and with phosphorus which is, in accordance with the present invention, characterised in that it comprises the following stages:

- a) the addition of a basic reagent to this liquid effluent to obtain a pH in the range from 8.5 to 13; and
- b) pulverisation of the basified liquid effluent derived from stage a) in a stream of air.

Advantageously, the basic reagent added to stage a) is unslaked or slaked lime in the form of powder, paste or liquid. This reagent may have a lime concentration $[\text{Ca}(\text{OH})_2]$ up to 1000 g/litre of reagent.

Preferably, stage b) is repeated a certain number of times for the same basified effluent: the passage number is in the range from 1 to 50.

Advantageously, at the start of stage b) an anti-foam catalyst is added, the quantity of which varies from 0 to 1 litres for cubic metre of liquid effluent which is to be treated.

According to a preferred form of embodiment, the method in accordance with the present invention may comprise a third stage or stage c) of sifting of the liquid effluent derived from stage b).

As previously indicated, the present invention likewise concerns a device for implementing the above method, which is of low cost. This device comprises:

- a mixing reactor for contacting the liquid effluent with the basic reagent, provided with an intake for this effluent and another intake for the basic reagent;
- an ammonia-extracting reactor, connected to the mixing reactor, and
- a tank for storing the treated liquid effluent derived from the ammonium-extracting reactor.

Advantageously, the mixing reactor comprises a device for measuring the pH of the medium connected to a means situated on the intake of basic reagent to automatically regulate the quantity thereof which is added.

Preferably, the ammonia-extracting reactor or degassing reactor comprises a lower part collecting especially the basified liquid effluent and an upper part in which is situated a pulverisation rack provided with nozzles, connected to the lower part of the reactor and comprising a feed pump, openings being provided between the two parts so that the exterior air can enter, an air exhaust fan being connected to this upper part. The nozzles of the pulverisation rack are, for example, of the cyclone type.

Advantageously, the upper part of the degassing reactor is connected to a devesiculer.

The following description, which is in no way restrictive in character, is to be read with reference to the single attached figure which is a diagrammatic vertical section of a part of a device for implementing the method according to the present invention.

In accordance with the invention, a method for treating a liquid effluent heavily loaded especially with nitrogen and/or with phosphorus comprises a first stage or stage a) of mixing a basic reagent with the liquid effluent which is to be treated. The pH of this effluent is thus brought to a value in the range from 8.5 to 13.

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The basic reagent is essentially composed of unslaked or slaked lime, present in the form of powder, liquid or paste and being able to have a concentration reaching 1000 g of equivalent $\text{Ca}(\text{OH})_2$ per litre of reagent.

This addition, by raising the pH, allows one to transform the nitrogenized compounds which are present in the liquid effluent in the form of ammonium ions, symbolised by the name N-NH_4^+ into gaseous ammonia (NH_3) dissolved in the liquid effluent.

Furthermore, the presence of lime leads to the precipitation in the form of calcic compounds the phosphatic compounds present in this effluent in the form of orthophosphates. Likewise the sulphurated compounds which are emitted in the form of a bad-smelling gas, sulphur dioxide (H_2S), are transformed into calcium sulphate, an inert product.

In a second stage or stage b) for extraction of ammonia, the liquid effluent derived from the preceding stage is transferred and pulverized in an air stream: the gaseous ammonia (NH_3) is entrained by the air. The transformation of the ammonium ions into ammonia is all the faster since the pH is in the range from 9.5 to 12.5. The temperature of 70°C maximum also increases the degassing.

At the start of this stage b), an anti-foam catalyst can be added, the quantity of which varies from 0 to 1 l/m³ of liquid effluent which is to be treated.

The method in accordance with the invention possibly comprises a third stage, or stage c) of sifting, allowing the separation of the particles in suspension after decanting, before storing the liquid effluent which has been treated.

The present invention likewise concerns a device for implementing the method described above.

This device comprises, firstly, a mixing reactor, not shown in the figure, in which the first stage is carried out. This reactor comprises an intake for the liquid effluent and an intake for the basic reagent. It is provided with a stirring means for mixing as intimately as possible the liquid effluent to be treated with the basic reagent.

This mixing reactor may also comprise means for the regulation of flow arranged on the intake for the basic reagent which are connected to a device for measuring the pH of the medium in reaction. This basic reagent, which is essentially made up of unslaked or slaked lime, is incorporated by sequences which are timed and repeated successively as many times as necessary until the desired pH is obtained: this can be realized automatically. Each incorporation sequence comprises four phases:

- measurement of the initial pH of the loaded liquid effluent,
- injection of dilution liquid of the basic reagent during a given time, for example 30 minutes, which liquid may be water, this operation being able to be carried out in masked time;

- the incorporation of the basic reagent diluted in the effluent to be treated during a given time, for example during successive periods each of 20 seconds,
- mixing of the effluent and of the basic reagent especially by stirring.

The duration of a sequence lasts from 30 minutes to 3 hours, in general.

The device in accordance with the present invention comprises, secondly, a degassing reactor designated as a whole by reference number 1 and connected to the mixing reactor.

This degassing reactor 1 is composed of two parts:

- a lower part 2 intended to receive the mixture derived from the mixing reactor. This lower part may, according to a preferred form of embodiment, be composed of several tanks 2a, 2b, 2c, each connected to the same evacuation pipe 3 towards a pulverisation rack 4;
- an upper part 5 comprising the pulverisation rack 4 which is provided with nozzles 6, for example of the cyclone type, which is connected to the lower part 2 of the reactor and is provided at this level with a pump 7: this pump 7 draws, in the pulverisation rack 4, the mixture present in the lower part 2. Openings 8 are arranged between the lower part 2 and upper part 5 to permit an intake of exterior air, an exhaust fan, not shown, being connected to this upper part: thus, an air stream is formed. As regards the exhaust fan, it causes a circulation of the air which is charged with ammonia whilst crossing the sheet of droplets of the mixture derived from the pulverisation rack 4.

This rack 4 can also comprise an intake for an anti-foam product: the latter has the aim of maintaining a regular fluidity to the basified liquid effluent.

The product derived from the nozzles is recovered in the upper part and recycled towards the pulverisation rack: the cycle number can reach 50, to obtain a given level of extraction of fixed ammoniacal nitrogen.

The treated liquid effluent derived from the degassing stage b) is conveyed towards storage tanks, possibly after sifting to eliminate especially the phosphatic compounds.

As regards the air drawn in the upper part, it is drawn out from the degassing reactor and is conveyed in a devesiculer 9 so as to relieve it of the droplets of liquid with which it has become loaded.

This air loaded with ammonia is returned into the atmosphere if the concentration is lower than the authorized ejection standards, or treated in a washing tower or by any other means allowing the ammonia to be collected or eliminated.

When the air loaded with ammonia is treated, the air which is thus purified can be recycled towards the openings arranged between the lower part and upper part of the degassing reactor.

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To remove 80% of the ammoniacal nitrogen contained in a pig slurry, the device in accordance with the present invention allows approximately 1 to 4 m³ of slurry to be treated per hour; the flow of air must be in the range from 6,000 to 15,000 m³/h.

To remove 60% of the ammoniacal nitrogen, this device allows approximately 2 to 8 m³/h pig slurry to be treated, with the same air flow as above.

To remove 40% of the ammoniacal nitrogen, this device allows approximately 3 to 10 m³/h pig slurry to be treated, the air flow being the same.

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